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EVALUATION OF TREE MORTALITY AND DECLINE IN THE SUNFLOWER GREEN TREE RESERVOIR, DELTA NATIONAL FOREST, MISSISSIPPI, 1981

by

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INTRODUCTION

The Sunflower Green Tree Reservoir (Sunflower Waterfowl Project) consists of 1500 acres of land on the Delta District of the Delta National Forest (NF) in Mississippi with approximately 85,500 hardwood trees. Among species of trees found on the reservoir are Nuttall oak, overcup oak, willow oak, sugarberry, water hickory, green ash, and cypress. The reservoir was established in 1958 and was developed to provide an area for hunting wild ducks. It has been flooded annually for the past 22 years. Water is pumped into it in October and drainage begins in February each year.

Recently, personnel of the National Forests in Mississippi became concerned with an apparently greater amount of tree mortality occurring on the reservoir as compared to that on adjacent unflooded areas. The Southern Hardwoods Laboratory, Southern Forest Experiment Station, Stoneville, MS, has conducted a 5 year thinning study in the area comparing growth and mast production of hardwoods in various thinning treatments in flooded and non-flooded areas. During this study period eleven percent of the trees died in flooded plots and none died in unflooded plots. Mast production was significantly reduced in flooded areas compared with unflooded areas

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(personal comm. John Francis). Although the area is used as a green tree reservoir, timber yield in the area is high priority; therefore, losses from reservoir management must be held to a minimum.

An evaluation was conducted jointly by the Southern Hardwoods Laboratory, Stoneville, Mississippi; Forest Pest Management, Pineville, Louisiana; and the Delta NF during August 1981. The evaluation was to continue annually for 4 more years. The objective of the evaluation was to provide the Delta NF with information relative to the influence of flooding in the Green Tree Reservoir on tree mortality, tree decline, and tree susceptibility to insect, disease and beaver attack.

METHODS

Selection and Measurement of Plots

Seventeen circular 1/5 acre plots were randomly selected in each, the flooded (approximately 1500 acres) and an adjacent unflooded area (approximately 1000 acres) (fig. 1). A 2 foot, numbered, flagged stake was placed at the center of each plot. Within each plot all trees 7" in diameter and larger were number tagged and evaluated. Each tree in a plot was numbered with paint, as well.

The following data were taken for each tree 7" dbh and larger within the plot:

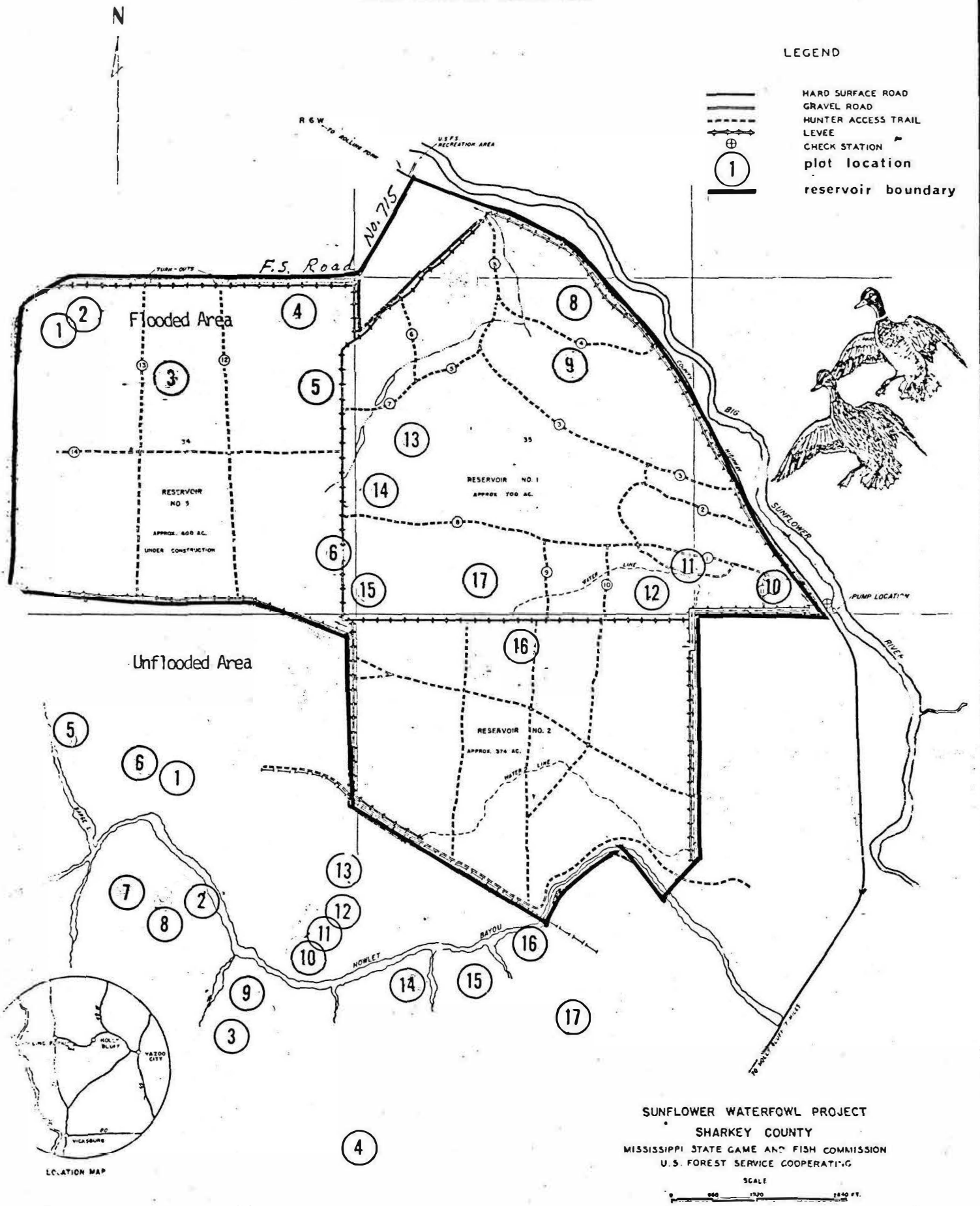
1. tree species
2. estimate of the elevation of each plot (ridges, upper flats, lower flats, sloughs)
3. estimate of silt depth (cm)
4. DBH of each tree (in.)
5. merchantable tree height (ft)
6. crown class
   a. dominant
   b. codominant
   c. intermediate
   d. suppressed
7. vigor class
   a. defined as the percent current crown (to the nearest 10%) of what should be present if that tree were in full vigor
8. damage category
   a. insect borers (light, medium, heavy)[6/]
   b. butt rot (light, medium, heavy)[7/]
   c. root rot
   d. beaver (light, medium, heavy)[7/]
   e. other

6/ Light = 1-3 attacks, medium = 4-10 attacks, heavy = 11+ attacks.

7/ Light = 1/4 bole affected, medium = 1/2 bole affected, heavy = 3/4 bole affected.

Figure 1. GREEN TREE RESERVOIR

PUBLIC WATERFOWL HUNTING AREA



In order to test for presence of herbicides a pint sample of soil was taken from the top 6 inches of even numbered plots, for a total of 16 samples. Samples were analyzed by the A & L Agricultural Laboratories, Inc., Memphis, Tennessee.

Design and Data Analysis

The design was completely randomized. Data were analyzed by a one way analysis of variance (ANOV). Comparisons were made between flooded and unflooded areas for percent of total number of trees dead, percent of trees in each vigor class, percent of trees in each crown class, percent of trees infested with insect borers (all degrees of damage), percent trees infested with insect borers (heavy), percent of trees infested with insect borers (medium), percent of trees infested with insect borers (light), percent of trees infected with butt rot organisms (all degrees of damage), percent of trees infected with butt rot organisms (heavy), percent of trees infected with butt rot organisms (medium), percent of trees infected with butt rot organisms (light), percent of trees with either insect borer or disease present, percent of trees with beaver damage, total volume of living sawtimber (MBF), and cm of silt deposit.

Since the plots in the flooded and unflooded areas showed considerable difference in species composition, two additional statistical analyses were performed using the same response variables as above in order to compare plots of similar tree species composition. One analysis compared 6 plots in the unflooded area containing two or more of the predominant tree species found in the flooded area (Nuttall oak, ash, sugarberry, and overcup oak) with 6 plots found in the flooded area. The other analysis compared 6 plots containing one or more Nuttall oaks in the unflooded area with 6 plots in the flooded area.

RESULTS

In the first analysis, flooded plots contained significantly ($P = 0.01$) greater volumes of live sawtimber, a significantly ($P = 0.01$) higher percent live sawtimber trees, and a significantly ($P = 0.01$) higher percent dead pulpwood trees than unflooded plots (table 1). The analysis showed that unflooded plots contained a significantly ($P = 0.01$) higher percentage of live pulpwood trees than flooded plots. These differences were, however, largely due to differences in stocking levels and species composition between the two areas. There was no significant difference ($P = 0.05$) between flooded and unflooded plots for percent live trees (sawtimber and pulpwood), percent dead sawtimber trees, or total percent dead trees (sawtimber and pulpwood).

When plots containing two or more of the same tree species were compared statistically, the flooded area contained a significantly ($P = 0.05$) a higher percentage of dead sawtimber and a significantly ($P = 0.05$) higher percentage of dead pulpwood and sawtimber. However, there were no significant differences ($P = 0.05$) for volume of sawtimber, percentage of live sawtimber, percentage of live pulpwood, or percentage of dead pulpwood.

Table 1. Comparisons of live and dead sawtimber and pulpwood on flooded and unflooded areas at the Green Tree Reservoir, Delta NF, MS, 1981.

	Volume of live sawtimber/ plot (B.F.)			PERCENT																	
				Live sawtimber trees			Live pulpwood trees			Live trees (Sawtimber & Pulp.)			Dead sawtimber trees			Dead pulpwood trees			Total trees dead (Sawtimber & pulpwood)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Flooded	2687**	2238	2661	60**	58	66	21**	25	19	81	82*	86	12	17*	12	7**	2	3	19	18*	15
Unflooded	1400**	2195	2243	40**	49	51	48**	45	36	89	94*	87	7	2*	10	5**	3	3	11	5*	13

* Means are significantly different at the 5% level of significance.

** Means are significantly different at the 1% level of significance.

(1) Analysis comparing all 17 plots in each the flooded and unflooded areas.

(2) Analysis comparing 6 plots in the unflooded area containing two or more of the flooded area predominant species (Nuttall oak, ash, sugarberry, or overcup oak) with corresponding numbered plots in the flooded area.

(3) Analysis comparing 6 plots in the unflooded area with one or more Nuttall oak with corresponding numbered plots in the flooded area.

The analysis comparing plots containing one or more Nuttall oaks showed no significant difference for any of the categories of live or dead sawtimber or pulpwood.

Generally, trees in unflooded plots had fuller, healthier crowns than those in flooded plots (table 2). The first analysis showed that unflooded plots had significantly ($P = 0.01$) more trees with crowns 30%+ and 50%+ healthy and significantly ($P = 0.05$) more trees with crowns 70%+ and 90%+ healthy than did flooded plots. Significantly ($P = 0.01$) more trees in the flooded plots were in the less healthy crown category (10-20%) than in unflooded plots. The analysis for plots containing two or more of the same tree species showed that the flooded area had significantly ($P = 0.05$) more trees in the 30-40 percent healthy crown category and significantly ($P = 0.01$) less trees in the 70%+ healthy crown category than did the unflooded area. The third analysis comparing plots containing one or more Nuttall oaks showed a significant difference ($P = 0.05$) for the 70+ healthy crown category only.

The analysis for all 17 plots showed insect borer attack was generally higher in flooded plots with significantly ($P = 0.05$) more trees attacked (light, medium, and heavy attacks combined). The light or medium attack categories were significantly more common in the flooded area (table 3). There was no significant difference between flooded and unflooded plots for heavy insect attack. The analysis for unflooded plots containing two or more of the same tree species as the flooded plots, showed significantly more trees in flooded plots with insect borer attack (all categories); however, the analysis for plots containing one or more Nuttall oak showed no significant differences for insect attack. Most of the insect attacks in flooded plots were caused by carpenter worms (Prionoxystus robiniae [Peck]) followed in number of attacks by ambrosia beetles (Platypus sp.) and then by red oak borers (Enaphalodes rufulus [Haldeman]) (table 4). Carpenter worm attacks were also the most prevalent borer damage in the unflooded area. Red oak borer attacks were the second most abundant insect damage found in the unflooded area.

For the analysis of all plots combined, approximately 16 and 11 percent of trees in the flooded and unflooded areas, respectively, had butt rot infections (all categories) (table 5). This difference was not significant ($P = 0.05$). Sixty-two percent of the trees in the flooded area showed either insect infestation or disease presence compared with 27 percent of the trees in the unflooded area. The analysis showed these means were significantly different ($P = 0.01$). The other two analyses showed neither significant difference ($P = 0.05$) for the presence of butt rot between flooded and unflooded areas for any of the categories (light, medium, heavy, or total) nor significant differences for the total insect or disease category.

Beaver damage was seen only on trees in the flooded plots; however, damage was so light that there was no significant difference between plots (flooded vs unflooded) for beaver damage in any of the three analyses (table 6).

Species composition differed considerably between flooded and unflooded areas (fig. 2). Sweetgum which is relatively intolerant to flooding was the

Table 2. Comparison of crown fullness classes for trees growing on the flooded and the unflooded areas of the Sunflower Green Tree Reservoir, Delta N.F., MS, 1981. Data are presented as percentage of trees falling within specified ranges of crown fullness.

	Portion of Crown Healthy																							
% of Crown Healthy	5-25%			26-45%			46-65%			65-85%			85-100%			30%+			50%+			70%+		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Flooded	8.4**	9.4	11.3	20.2	25.4*	27.1	23.4	32.3	29.2	35.7	22.2	23.4	9.7*	11.2	10.0	88.9**	91.0	90.7	68.8**	65.6	63.7	45.0*	33.3**	34.4*
Unflooded	1.3**	2.7	2.8	11.9	6.6*	12.2	22.1	23.1	17.6	40.7	41.8	47.4	21.7*	21.5	17.0	96.2**	93.0	94.2	84.3**	86.4	81.9	62.2*	63.3**	64.4*

* Means significantly different at the five percent level of significance.

** Means significantly different at the one percent level of significance.

(1) Analysis comparing all 17 plots in each of the flooded and unflooded areas.

(2) Analysis comparing 6 plots in the unflooded area containing two or more of the flooded area predominant species (Nuttall oak, ash, sugarberry, or overcup oak) with corresponding numbered plots in the flooded area.

(3) Analysis comparing 6 plots in the unflooded area with one or more Nuttall oak with corresponding numbered plots in the flooded area.

Table 3. Comparison of flooded and unflooded areas for insect borer attack at the Sunflower Green Tree Reservoir, Delta NF, MS, 1981.

	% of Trees with Insect Borer Attack											
	Light[1/]			Medium[2/]			Heavy[3/]			Total (light, medium, & heavy)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Flooded	29**	28	23	13**	15	16	4	4	3	46**	47*	42
Unflooded	12**	15	17	4**	8	10	1	0	0	17**	23*	27

1/ Light = 1-3 attacks

2/ Medium = 4-10 attacks

3/ Heavy = 11+ attacks

* Corresponding means are significantly different at the 5% level of significance.

** Corresponding means are significantly different at the 1% level of significance.

(1) Analysis comparing all 17 plots in each of the flooded and unflooded areas.

(2) Analysis comparing 6 plots in the unflooded areas containing two or more of the flooded area predominant species (Nuttall oak, ash, sugarberry, or overcup oak) with corresponding numbered plots in the flooded area.

(3) Analysis comparing 6 plots in unflooded area containing one or more Nuttall oak with corresponding numbered plots in the flooded area.

Table 4. Insects attacking trees in the flooded and unflooded areas at the Sunflower Green Tree Reservoir, Delta NF, MS, 1981.

	Number of Trees with One or More Attacks								
	CW[1/]	ROB[2/]	Amb.[3/]	RHAB[4/]	OCB[5/]	AB[6/]	FHB[7/]	WOB[8/]	TOTAL
Flooded	102	15	23	1	7	2	5	4	162
Unflooded	31	21	1	0	0	0	1	1	55

1/ Carpenter worm - Prionoxystus robiniae (Peck)

2/ Red oak borer - Enaphalodes rufulus (Haldeman)

3/ Ambrosia beetle - Platypus sp.

4/ Redheaded ash borer - Neoclytus acuminatus (F.)

5/ Oak clearwing borer - Paranthrene simulans (Grote)

6/ Ash borer - Podosesia syringae fraxini Lugger

7/ Flat headed borers - family Buprestidae

8/ White oak borer - Goes tigrinus (DeGeer)

Table 5. Comparison of flooded and unflooded areas for butt rot at the Sunflower Green Tree Reservoir, Delta NF, MS, 1981.

	% of Trees with Butt Rot																	
	Light[1]			Medium[2]			Heavy[3]			Total (Medium, Heavy, & Light)			Total Insect or Disease Damage		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Flooded	8	19	19	4	3	3	4	3	6	16	25	28	62**	73	71
Unflooded	1	0	3	6	11	8	4	7	0	11	18	27	27**	41	45

[1] Light = 1/4 of bole affected

[2] Medium = 1/2 of bole affected

[3] Heavy = 3/4 of bole affected

(1) Analysis comparing all 17 plots in both the flooded and unflooded areas.

(2) Analysis comparing 6 plots in the unflooded area containing two or more of the flooded area predominant species (Nuttall oak, ash, sugarberry, or overcup oak) with corresponding numbered plots in the flooded area.

(3) Analysis comparing 6 plots in the unflooded area containing one or more Nuttall oaks with corresponding numbered plots in the flooded area.

** Means significantly different at the 1% level of significance.

Table 6. Comparison of flooded and unflooded areas for beaver damage.

	% of Trees with Beaver Damage											
	Light[1/]			Medium[2/]			Heavy[3/]			Overall		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Flooded	1.2	4.0	0.0	1.0	2.0	1.3	0.3	1.0	0.0	2.6	6.0	0.0
Unflooded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1/ Light = 1/4 of bole affected

2/ Medium = 1/2 of bole affected

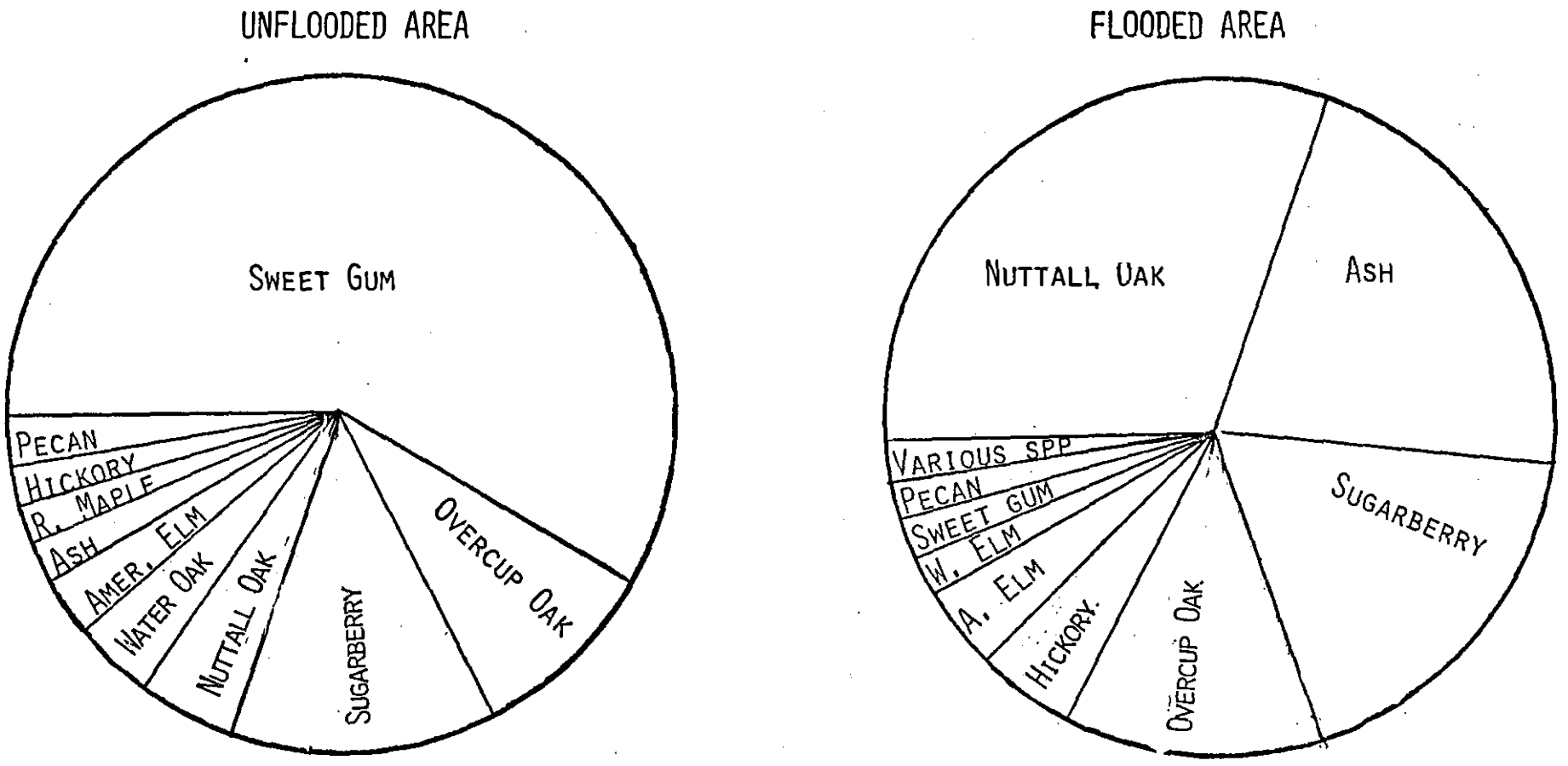
3/ Heavy = 3/4 of bole affected

(1) Analysis comparing all 17 plots in each the flooded and unflooded area.

(2) Analysis comparing 6 plots in the unflooded area containing two or more of the flooded area predominant species (Nuttall oak, ash, sugarberry, or overcup oak) with corresponding numbered plots in the flooded area.

(3) Analysis comparing 6 plots in the unflooded area containing one or more Nuttall oaks with corresponding numbered plots in the flooded area.

FIGURE 2. SPECIES COMPOSITION SUNFLOWER GREEN TREE RESERVOIR



most prevalent species in the unflooded area with 58 percent of the trees in plots being of this species. Nuttall oak and ash which are more tolerant to flooding were the most prevalent species in the flooded area with 30 and 21 percent of the trees, respectively, being of these species.

None of the analyses showed significant differences ($P = 0.05$) between flooded and unflooded areas for any of the crown dominance categories (table 7).

Analysis of soil samples for herbicides showed that neither Triazines, Karmex nor 2,4,5-T were present in flooded or unflooded areas. The detection limit was 0.02 ppm.

Silt deposits on the flooded area averaged 0.26 cm and 0.07 cm/plot on the unflooded area. This difference was significant at the 1 percent level of significance.

SUMMARY AND DISCUSSION

The analysis of all plots combined showed no significant difference between flooded and unflooded areas for mortality, except for the pulpwood category. The analysis for unflooded plots containing two or more of the predominant species in flooded plots showed significantly ($P = 0.05$) greater sawtimber mortality and greater combined sawtimber and pulpwood mortality in the flooded plots than unflooded plots, but did not show a significant difference in pulpwood mortality alone. The sawtimber and pulpwood stocking levels of unflooded plots was similar to flooded plots. This indicates that where species and timber stocking levels were similar there was more mortality in flooded plots. However, unflooded plots containing one or more Nuttall oaks and stocking levels similar to flooded plots showed no difference in mortality to flooded plots.

All three analyses tended to show plots in the unflooded area contained healthier crowns and fewer insect borer attacks than flooded areas. No significant differences occurred for disease incidence or beaver damage between flooded and unflooded areas for any of the analyses.

No problems are indicated from silt buildup in the flooded area or from pesticides in the water pumped in from the river.

It is important to point out that the randomly selected study plots in the flooded and unflooded areas turned out to be markedly different in tree species composition and tree size. These differences complicated the analyses and made direct comparisons of variables, especially mortality, between flooded and unflooded plots most difficult. An attempt made to compare only those plots having similar species composition seemed to shed some light on the findings, yet the overall results were still somewhat inconclusive. A differently designed study is needed to fully assess the effects of flooding. Another area near the reservoir is scheduled to be flooded soon. Plots should be established prior to flooding to insure that changes in species composition are detected over time.

Table 7. Comparison of percent trees in crown classes between flooded and unflooded areas.

Crown Class	Flooded			Unflooded		
	(1)	(2)	(3)	(1)	(2)	(3)
Dominant	26	20	14	28	28	21
Codominant	36	40	43	39	35	43
Intermediate	15	17	14	10	12	14
Suppressed	20	20	21	23	22	21

(1) Analysis comparing all 17 plots in each of the flooded and unflooded areas.

(2) Analysis comparing 6 plots in the unflooded areas containing two or more of the flooded area predominant species (Nuttall oak, ash, sugarberry, or overcup oak) with corresponding numbered plots in the flooded area.

(3) Analysis comparing 6 plots in the unflooded area containing one or more Nuttall oaks with corresponding numbered plots in the flooded area.

RECOMMENDATIONS

The present evaluation as structured should be discontinued. To fully assess the effects of longterm flooding on hardwood tree species, a study should be conducted by USDA Forest Service Research beginning with initial data collection prior to flooding and observations continued until rotation age if possible. If flooded and unflooded areas are compared, both areas should have similar elevation, tree composition at the outset, tree age at the outset, and timber management practices except for flooding.

Until definitive data are obtained on which to base management practices the following recommendations are offered for green tree reservoirs:

(1) flood the reservoir (or portions of it) in alternate years to minimize stress due to flooding;

(2) apply water as late as possible in the fall (late October), preferably after the first frost;

(3) remove water as early as possible in the spring but no later than bud break.

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